Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

General Certificate of Education
Advanced Level Examination
June 2014

Physics A PHYA4/1

Unit 4 Fields and Further Mechanics
Section A

Wednesday 11 June 2014 1.30 pm to 3.15 pm

In addition to this paper you will require:
- an objective test answer sheet
- a black ball-point pen
- a calculator
- a question paper/answer book for Section B (enclosed)
- a Data and Formulae booklet.

Time allowed
- The total time for both sections of this paper is 1 hour 45 minutes. You are advised to spend approximately 45 minutes on this section.

Instructions
- Use a black ball-point pen.
- Answer **all** questions in this section.
- For each question there are four responses. When you have selected the response which you think is the most appropriate answer to a question, mark this response on your answer sheet.
- Mark all responses as instructed on your answer sheet. If you wish to change your answer to a question, follow the instructions on your answer sheet.
- Do all rough work in this book **not** on the answer sheet.

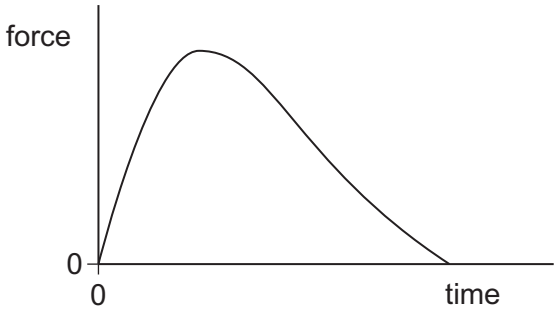
Information
- The maximum mark for this section is 25.
- All questions in Section A carry equal marks. No deductions will be made for incorrect answers.
- A *Data and Formulae Booklet* is provided as a loose insert.
- The question paper/answer book for Section B is enclosed within this question paper.

Multiple choice questions

Each of Questions **1** to **25** is followed by four responses, **A**, **B**, **C**, and **D**. For each question select the best response and mark its letter on the answer sheet.

You are advised to spend about **45 minutes** on this section.

1 The graph shows how the force acting on a rocket varies with time.



Which one of the following is represented by the area under the graph?

A distance travelled

B gain in kinetic energy

C change in velocity

D change in momentum

2 A golf club strikes a stationary golf ball of mass $4.8 \times 10^{-2}\,\text{kg}$ and the ball leaves the club with a speed of $95\,\text{m s}^{-1}$. If the average force exerted on the ball is $7800\,\text{N}$, how long are the ball and club in contact?

A $5.8 \times 10^{-4}\,\text{s}$

B $1.2 \times 10^{-2}\,\text{s}$

C $0.51\,\text{s}$

D $0.58\,\text{s}$

3 Water of density $1000\,\text{kg m}^{-3}$ flows out of a garden hose of cross-sectional area $7.2 \times 10^{-4}\,\text{m}^2$ at a rate of $2.0 \times 10^{-4}\,\text{m}^3$ per second. How much momentum is carried by the water leaving the hose per second?

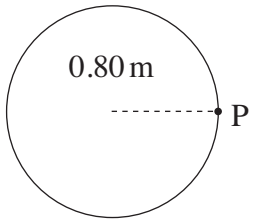
A $5.6 \times 10^{-5}\,\text{N s}$

B $5.6 \times 10^{-2}\,\text{N s}$

C $0.20\,\text{N s}$

D $0.72\,\text{N s}$

4 A model car moves in a circular path of radius $0.80\,\text{m}$ at an angular speed of $\frac{\pi}{2}\,\text{rad}\,\text{s}^{-1}$.



What is its displacement from point P $6.0\,\text{s}$ after passing P?

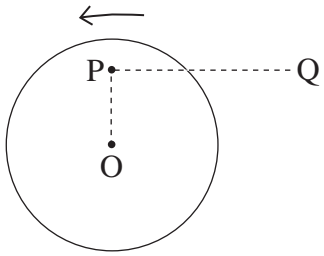
A zero

B $0.4\pi\,\text{m}$

C $1.6\,\text{m}$

D $1.6\pi\,\text{m}$

5 A small mass is placed at P on a horizontal disc which has its centre at O. The disc rotates anti-clockwise about a vertical axis through O with constant angular speed.



Which one of the following describes the force which keeps the mass at rest relative to the disc when in the position shown?

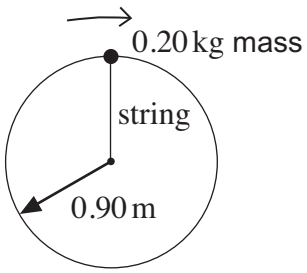
A the weight of the mass

B a frictional force from P to Q

C a frictional force directed away from O

D a frictional force directed towards O

6 A $0.20\,\text{kg}$ mass is whirled round in a vertical circle on the end of a light string of length $0.90\,\text{m}$.



At the top point of the circle the speed of the mass is $8.2\,\text{m s}^{-1}$. What is the tension in the string at this point?

A $10\,\text{N}$

B $13\,\text{N}$

C $17\,\text{N}$

D $20\,\text{N}$

7 Which line, **A** to **D**, in the table gives the amplitude and frequency of a body performing simple harmonic motion whose displacement x at time t is given by the equation $x = P\cos Qt$?

	Amplitude	Frequency
A	$\frac{P}{2}$	$\frac{Q}{2\pi}$
B	P	$2\pi Q$
C	P	$\frac{Q}{2\pi}$
D	$2P$	$\frac{Q}{2\pi}$

8 The tip of each prong of a tuning fork emitting a note of $320\,\text{Hz}$ vibrates in simple harmonic motion with an amplitude of $0.50\,\text{mm}$.
What is the speed of each tip when its displacement is zero?

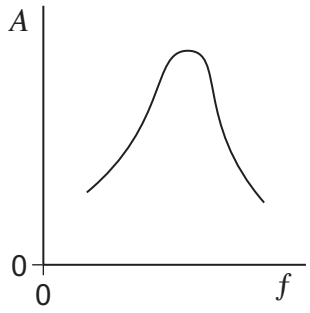
A zero

B $0.32\pi\ \text{mm s}^{-1}$

C $160\pi\ \text{mm s}^{-1}$

D $320\pi\ \text{mm s}^{-1}$

9 A periodic force is applied to a lightly-damped object causing the object to oscillate. The graph shows how the amplitude A of the oscillations varies with the frequency f of the periodic force.



Which one of the following statements best describes how the shape of the curve would differ if the damping had been greater?

A The curve would be lower at all frequencies.

B The curve would be higher at all frequencies.

C The curve would be unchanged except at frequencies above the resonant frequency where it would be lower.

D The curve would be unchanged except at frequencies above the resonant frequency where it would be higher.

10 A spacecraft of mass m is at the mid-point between the centres of a planet of mass M_1 and its moon of mass M_2. If the distance between the spacecraft and the centre of the planet is d, what is the magnitude of the resultant gravitational force on the spacecraft?

A $\dfrac{Gm(M_1 - M_2)}{d}$

B $\dfrac{Gm(M_1 + M_2)}{d^2}$

C $\dfrac{Gm(M_1 - M_2)}{d^2}$

D $\dfrac{Gm(M_1 + M_2)}{d}$

11 Which one of the following statements about gravitational potential is correct?

A Gravitational potential can have a positive value.

B The gravitational potential at the surface of the Earth is zero.

C The gravitational potential gradient at a point has the same numerical value as the gravitational field strength at that point.

D The unit of gravitational potential is $\mathrm{N\,kg^{-1}}$.

12 Which one of the following statements is correct?

The force between two charged particles

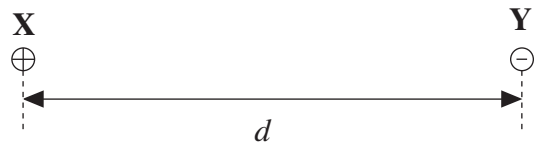
A is always attractive.

B can be measured in $\mathrm{C^2\,F^{-1}\,m^{-1}}$.

C is directly proportional to the distance between them.

D is independent of the magnitude of the charges.

13 Two point charges, **X** and **Y**, exert a force F on each other when they are at a distance d apart.



When the distance between them is $20\,\mathrm{mm}$, the force they exert on each other is $0.5\,F$.

What is the distance d?

A $7\,\mathrm{mm}$

B $14\,\mathrm{mm}$

C $15\,\mathrm{mm}$

D $28\,\mathrm{mm}$

14 Which one of the following statements is correct?

When a negative ion is projected into an electric field

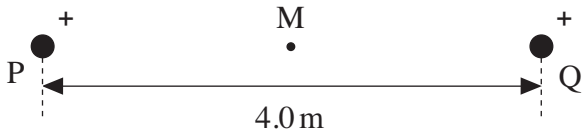
A the field can change the magnitude of the velocity but not its direction.

B the field can change the direction of the velocity but not its magnitude.

C the field can change both the magnitude and the direction of the velocity.

D the ion will accelerate in the direction of the field.

15 Two identical positive point charges, P and Q, are separated by a distance of $4.0\,\text{m}$. The resultant electric potential at point M, which is mid-way between the charges, is $25.0\,\text{V}$.



What would be the resultant electrical potential at a point $1.0\,\text{m}$ closer to P?

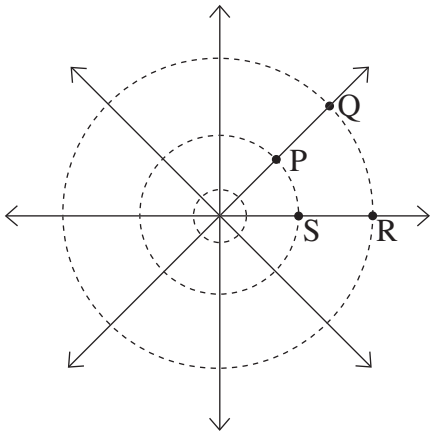
A $8.3\,\text{V}$

B $12.5\,\text{V}$

C $33.3\,\text{V}$

D $37.5\,\text{V}$

16 The diagram below shows the field lines and equipotential lines around an isolated positive point charge.



Which one of the following statements concerning the work done when a small charge is moved in the field is **incorrect**?

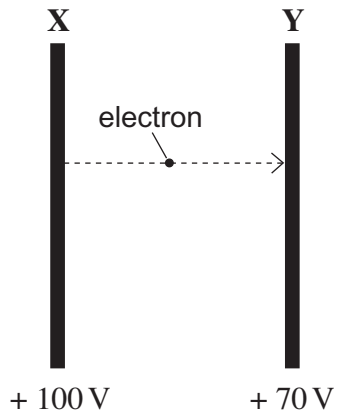
A When it is moved from either P to Q or S to R, the work done is the same in each case.

B When it is moved from Q to R no work is done.

C When it is moved around the path PQRS, the overall work done is zero.

D When it is moved around the path PQRS, the overall work done is equal to twice the work done in moving from P to Q.

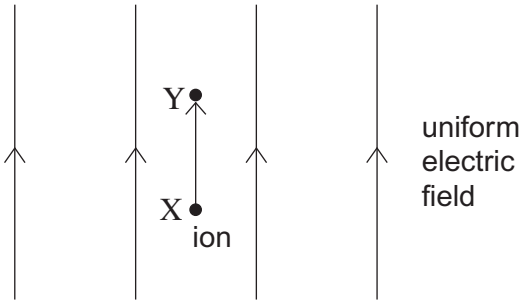
17 Two fixed parallel metal plates **X** and **Y** are at constant potentials of + 100 V and + 70 V respectively. An electron travelling from **X** to **Y** experiences a change of potential energy ΔE_p



Which line, **A** to **D**, in the table shows correctly the direction of the electrostatic force F on the electron and the value of ΔE_p?

	Direction of F	**ΔE_p**
A	towards **X**	+ 30 eV
B	towards **Y**	– 30 eV
C	away from **X**	+ 30 eV
D	away from **Y**	– 30 eV

18 A uniform electric field of electric field strength E is aligned so it is vertical. An ion moves vertically through a small distance Δd from point X to point Y in the field. There is a uniform gravitational field of field strength g throughout the region.



Which line, **A** to **D**, in the table correctly gives the gravitational potential difference, and the electric potential difference, between X and Y?

	Gravitational potential difference	**Electric potential difference**
A	$g\Delta d$	$E\Delta d$
B	$g\Delta d$	$\frac{E}{\Delta d}$
C	$\frac{g}{\Delta d}$	$E\Delta d$
D	$\frac{g}{\Delta d}$	$\frac{E}{\Delta d}$

19 Initially a charged capacitor stores $1600\,\mu J$ of energy. When the pd across it decreases by $2.0\,V$, the energy stored by it becomes $400\,\mu J$.

What is the capacitance of this capacitor?

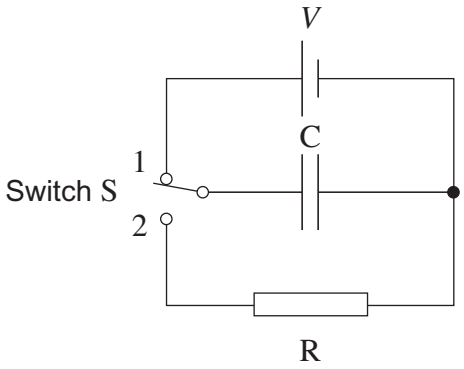
A $100\,\mu F$

B $200\,\mu F$

C $400\,\mu F$

D $600\,\mu F$

20 Switch S in the circuit is held in position 1, so that the capacitor C becomes fully charged to a pd V and stores energy E.



The switch is then moved quickly to position 2, allowing C to discharge through the fixed resistor R. It takes 36 ms for the pd across C to fall to $\frac{V}{2}$. What period of time must elapse, after the switch has moved to position 2, before the energy stored by C has fallen to $\frac{E}{16}$?

A 51 ms

B 72 ms

C 432 ms

D 576 ms

21 The path followed by an electron of momentum p, carrying charge $-e$, which enters a magnetic field at right angles, is a circular arc of radius r.

What would be the radius of the circular arc followed by an α particle of momentum $2p$, carrying charge $+2e$, which entered the same field at right angles?

A $\frac{r}{2}$

B r

C $2r$

D $4r$

22 In which one of the following applications does electromagnetic induction **not** take place?

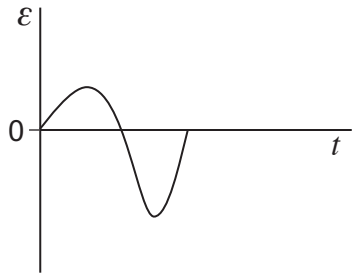
A the generators at a nuclear power station

B the ac power adapter for a laptop computer

C the wings of an aircraft cutting through the Earth's magnetic field

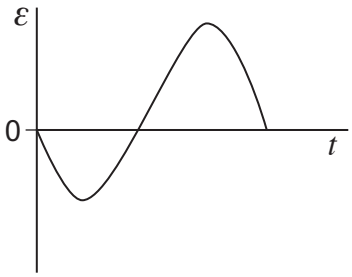
D the back up capacitor of an electric timer

23 When a magnet is dropped through an aluminium ring an emf is induced. A data logger connected to the ring records the variation of the induced emf ε with time t as shown below.

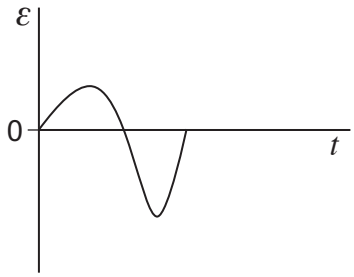


In a second experiment, the magnet is dropped from a greater height.

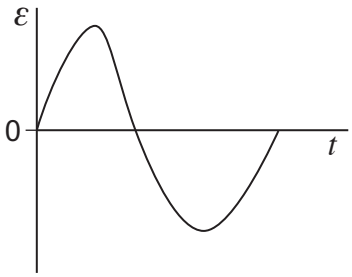
Which one of the following graphs best represents the induced emf in the second experiment?



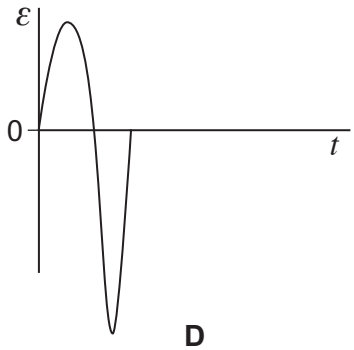
A



B



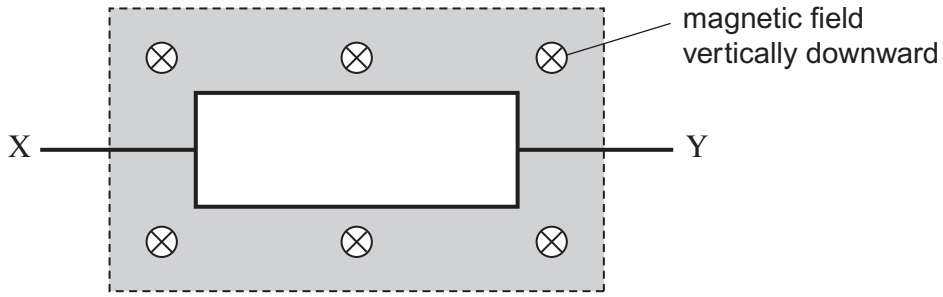
C



D

24 A rectangular coil of area A has N turns of wire. The coil is in a uniform magnetic field, as shown in the diagram.

When the coil is rotated at a constant frequency f about its axis XY, an alternating emf of peak value ε_0 is induced in it.



What is the maximum value of the magnetic flux linkage through the coil?

A $\dfrac{\varepsilon_0}{2\pi f}$

B $\dfrac{\varepsilon_0}{\pi f}$

C $\pi f \varepsilon_0$

D $2\pi f \varepsilon_0$

25 A transformer has 1150 turns on the primary coil and 500 turns on the secondary coil. The primary coil draws a current of $0.26\,\text{A}$ from a $230\,\text{V}$ ac supply. The current in the secondary coil is $0.50\,\text{A}$. What is the efficiency of the transformer?

A 42%

B 50%

C 84%

D 100%

END OF QUESTIONS